

CHAPTER 4

Northern Forest Communities

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DESCRIPTION

The term northern forest, as applied in Wisconsin, is primarily a geographic designation and does not in itself imply any specific species composition . . . It may be characterized as a region of mixed deciduous and coniferous forests occurring north of the tension zone.

The term *northern forest*, as applied in Wisconsin, is primarily a geographic designation and does not in itself imply any specific species composition. In broad terms, it may be characterized as a region of mixed deciduous and coniferous forests that represent one of the two distinct climatic zones in Wisconsin as separated by a loosely defined S-shaped transition belt known as the “tension zone.” The region north of this zone is generally called the northern forest (see Fig. 9).

Forest communities, present and historic, display considerable diversity in composition of dominant species. About 30 tree species occur in the northern forest as a whole, although fewer than ten are usually found in any given community,

with dominance generally being shared by only two of three. Throughout the region, mature stands on the medium to rich soils (loams and silt loams) are dominated by various mixtures of five or six principal species: sugar maple, basswood, hemlock, yellow birch, white ash, and American beech. Red oak and red maple are the most common minor associates. In presettlement times, white pine was also a common associate in these northern hardwood forests. The poorer soils (sands and loamy sands) are generally dominated by mixtures of pines (jack, red, and white), aspen, white birch, red maple, and red oak. Extensive wetland forests are also common to this region. These can be divided into two basic types: conifer swamps (black spruce/tamarack and white cedar) and hardwood swamps (black ash, red maple, and elm).

These broadly described forest types, based upon dominant vegetation, only begin to reflect the total biological diversity of forest communities of the region. A system of ecological classification of forest communities and sites on which they occur is necessary. Such a system has been developed for forests in northern Wisconsin (Kotar et al. 1988) (Table 2) and will be completed for the rest of the state by 1994.

STATUS

PAST

POST-GLACIAL ENVIRONMENT

The entire area of present-day northern forest has been affected by Pleistocene glaciation. Several major glaciations and countless minor ice advances and recessions have created a complex pattern of ice and meltwater-influenced deposits. Some of these deposits were subsequently covered by wind-blown silty or loamy material called loess. This tremendously complex array of deposits formed the parent material from which present soils have developed and are, in fact, still in the process of development. Although soil scientists recognize several hundred soil classes

Curtis (1959) Communities	Kotar et al. (1988) Habitat Types
Northern Dry Forest	<i>Acer-Quercus/Vaccinium</i> <i>Quercus-Acer/Epigaea</i> <i>Quercus/Gaultheria-Ceanothus</i>
Northern Dry-Mesic Forest	<i>Pinus/Maianthemum-Vaccinium</i> <i>Pinus/Amphicarpa</i> <i>Quercus/Amphicarpa</i> <i>Acer/Vaccinium-Desmodium</i> <i>Acer/Vaccinium-Viburnum</i> <i>Acer-Quercus/Viburnum</i> <i>Acer/Athyrium</i>
Northern Mesic Forest	<i>Acer/Viola-Osmorhiza</i> <i>Acer/Hydrophyllum</i> <i>Acer/Caulophyllum-Circaea</i> <i>Acer-Tsuga/Dryopteris</i> <i>Acer-Fagus/Dryopteris</i> <i>Acer-Tsuga/Maianthemum</i>
Northern Wet-Mesic Forest	<i>Tsuga/Maianthemum-Coptis</i>

Table 2
An ecological classification system for the northern forest.

The dominant vegetation of the northern forest only begins to reflect the total biological diversity of the region.

within the region of the northern forest, the present soils can be grouped into four broad categories based on the mode of glacial deposition of parent material. These are:

- ▲ Ground moraines or till plains, consisting of assorted material including boulders, gravel, and sand but usually also containing considerable amounts of silt and clay. Soils developed from till are usually the most productive.
- ▲ End moraines and recessional moraines. These deposits are also composed of till, but are usually coarser textured than are ground moraines, and they form more rugged topography. The resulting soils are somewhat drier and have lower nutrient content than do soils derived from ground moraines.
- ▲ Pitted outwash. These meltwater-deposited sands and gravels contain depressions (pits) that often have steep slopes and may be filled with water. Several large areas in northern Wisconsin are dominated by this type of landform (e.g., Burnett, Washburn, Vilas, and Oneida counties).

- ▲ Outwash plains and terraces. These deposits are similar to those of the pitted outwash, often sandier than pitted outwash, but the terrain is flat or only gently sloping. Unless modified by a blanket of loess, pitted outwashes and outwash plains form the driest and least fertile soils of the region.

These four basic types of glacial deposits form a moisture-nutrient gradient, which is the strongest factor controlling the establishment of invading plant species. Plants themselves exert considerable influence on soil development. Even

The northern forest landscape. We see a matrix of forest with aquatic features imbedded. The continuous forest is a mosaic of old-growth stands of hemlock (Plum-Star Lakes Hemlocks State Natural Area is between the lakes), wildlife openings, and adjacent stands that have been harvested (foreground). *Photo by Michael J. Mossman.*



though the original parent material has been modified to varying degrees since the last glaciation (10,000 to 60,000 years ago, depending on location), the distinctions due to parent material persist.

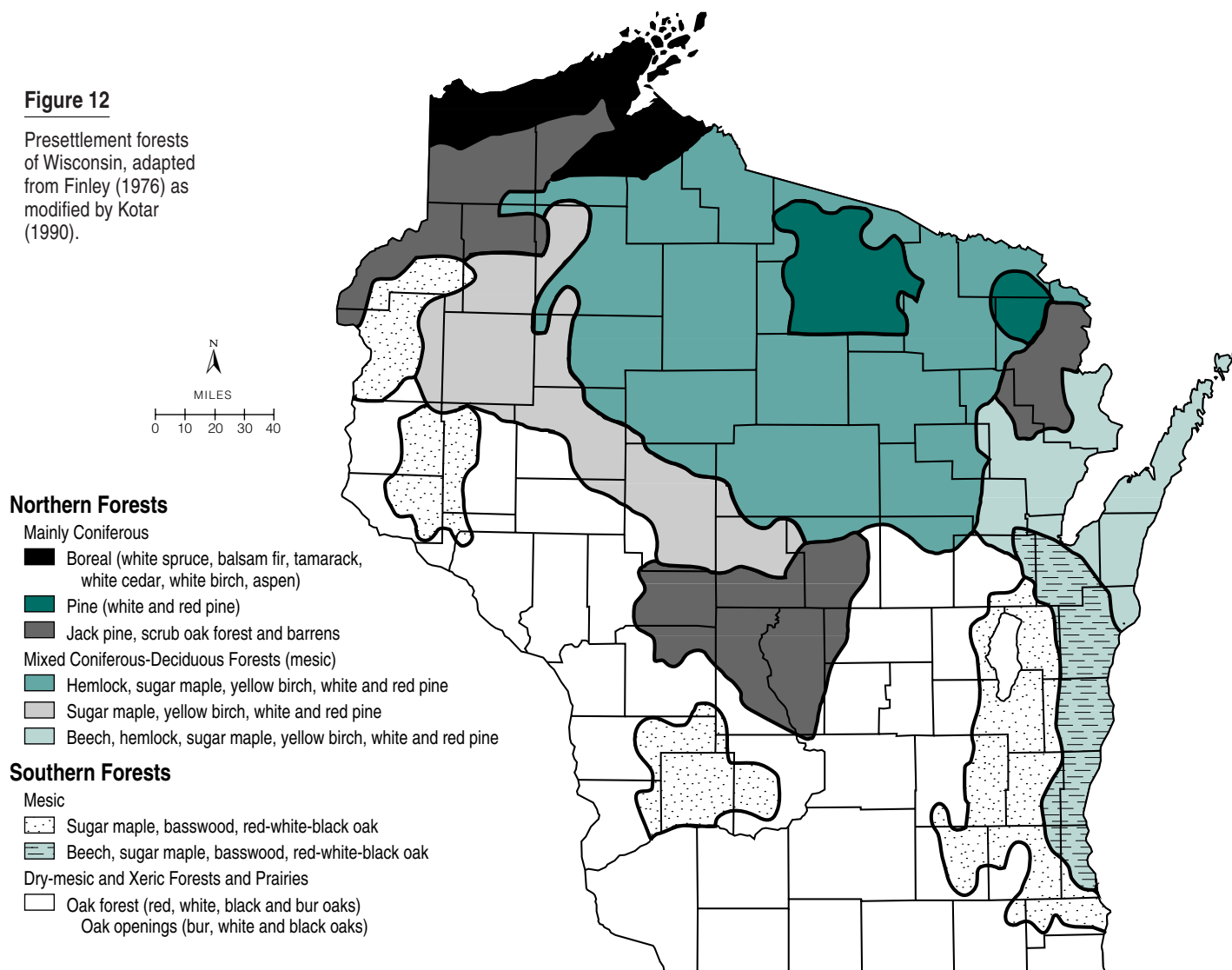
Present community composition is the result of environmental influence (soil and climate) and various historical factors. It is not meaningful to speak of “original vegetation” without reference to some specific time period. Many plant species found in Wisconsin today may have been present before the Pleistocene, but not necessarily in present locations and in present combinations. Paleoecologists have determined that present Wisconsin vegetation consists of elements from three distinct floristic provinces: the Boreal, the Prairie, and the Alleghenian (Hulten 1937, Cain

1944). Members of the Alleghenian province are more or less distributed throughout the southern and northern forests, while the boreal species are more prevalent in the northern half of the state and prairie species more prevalent in the southern half.

There is evidence that many species are still extending their ranges; consequently, floristic stability on the geologic scale may not be reached for some time even if the climate remains stable. This fact is often overlooked, especially in North America where the presettlement condition of the vegetation is often presumed to have been in a relatively static climax state. This change, however, is so slow that most of the changes seen in the past 150 years can be attributed to the influences of Euro-American settlement.

Figure 12

Presettlement forests of Wisconsin, adapted from Finley (1976) as modified by Kotar (1990).



COMPOSITION OF PRESETTLEMENT FORESTS

The exact nature of the floristic and structural composition and the geographic variation of the northern forest in presettlement times has never been described, and it probably will never be known with certainty. However, descriptions and occurrences of prominent forest types, at least in terms of tree species composition, were recorded by numerous early observers (e.g., Knapp 1871, Chamberlin 1877, Warden 1881). These early observers had already recognized the tension zone, without using the term, and consistently described four to six forest types occurring north of the zone: (1) pine forests, composed of white pine and red pine mixtures with no hardwoods; (2) mixtures of hemlock, sugar maple, and yellow birch, with, to the east, beech and large white pine; (3) scrub pines and scrub oaks; (4) hardwoods without conifers—mainly sugar maple, yellow birch, basswood and sometimes a mixture of red oak and white oak; (5) swamp forests composed of spruce, fir, tamarack, and white cedar; and (6) oak openings or savanna (only south of the tension zone).

The best information on the composition of the northern forest during the earliest period of Euro-American settlement comes from the records of the rectangular survey of public lands (General Land Office Surveys). These surveys contain a systematic record of the kinds and sizes of trees used as witnesses for lines and corners, as well as more or less detailed accounts of vegetational changes encountered. Finley (1976) produced a map of the presettlement vegetation of Wisconsin based on survey records contained in 671 volumes of surveyor notebooks. These records describe 54,000 square-mile sections and 110,000 linear miles of traverse. Although surveyors did not record

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forest communities—they only identified individual trees—Finley constructed abstract communities based on dominant tree species. He organized the data into 11 forest community types, seven of which represent the upland forests of northern Wisconsin. Figure 12 is a redrawn and simplified version of Finley's large and complex map. It shows the primary distribution of the six major forest types of northern Wisconsin plus three southern forest types. Numerous scattered fragments of depicted types were deleted. The six northern forest types are described as follows:

1. **Boreal forest**—white spruce, balsam fir, tamarack, white cedar, white birch, aspen. This forest type occurred in a limited area of the extreme northern part of the state, near Lake Superior. Most ecologists today agree that this community type, although resembling the boreal forests of Canada, is a distinct geographic variant of its northern namesake.
2. **Pine forest**—dominated by white pine and red pine. Contrary to the common belief that most of northern Wisconsin was covered by extensive pure stands of white pine and red pine, this forest was extremely limited even before Euro-American settlement. The most extensive block occurred in Vilas and Oneida counties.
3. **Jack pine, scrub oak forests, and barrens**. This is a loosely described type characterized by mixtures of poor-quality trees or poorly stocked stands of jack pine, pin oak or bur oak, or sometimes red oak. Mixtures of red pine and white pine, red maple, aspen, and white birch were often included. Figure 12 shows three principal areas of occurrence: Washburn, Burnett, and Douglas

counties in the northwest; Marinette County in the northeast; and Juneau, Adams, and Jackson counties in the central part of the state.

4. **Hemlock, sugar maple, and yellow birch, with mixtures of white pine and red pine.** This was the largest and perhaps the most characteristic forest formation in northern Wisconsin. It is also sometimes referred to as the "hemlock-northern hardwood" or simply the "northern hardwood" forest.

5. **Sugar maple and yellow birch, with a mixture of red pine and white pine.** This type represents the southern and western transition of the preceding type. Absence of hemlock, which reaches the western limit of its natural range in these regions, is its main characteristic. Although this community designation may appear arbitrary, the abrupt termination of the range of hemlock, a species which is ubiquitous eastward to the Atlantic coast, suggests a significant climatic shift.

6. **Beech, hemlock, sugar maple, and yellow birch, with a mixture of red pine and white pine.** American beech is another tree species that reaches the western limit of its range in Wisconsin. Just as in the case of hemlock, climatic influence is presumed to control the range of beech, although the role of calcareous soils, climate, and incomplete post-Pleistocene migration have been suggested as additional factors (Davis et al. 1986).

FACTORS CONTROLLING THE DYNAMICS OF PRESETTLEMENT FORESTS

Before we examine the present status of the northern forest complex, we must consider the factors controlling the composition and perpetuation of presettlement forests. Simply because present forest communities are known to be largely the result of human-caused disturbances, it

does not follow that presettlement forests were unaffected by perturbation and were stable and in balance with regional climate. Of the six presettlement forest types described above, none can be explained without invoking some form of environmental disturbance. The three northern hardwood types (4, 5, and 6 above) could presumably self-perpetuate without the aid of disturbance, because sugar maple, hemlock, beech, and to some degree yellow birch are shade tolerant. However, the presence of shade-intolerant white pine and especially red pine in these communities could not be explained without a disturbance factor.

Although fires occurred less frequently in mesic hardwood stands than they did in coniferous forests, many fire-scarred trees and stumps predating the logging era were observed by early surveyors. However, severe and extensive fires were probably not very common in northern Wisconsin. The main evidence for this is a very low occurrence of aspen and birch stands among presettlement forests. In the Lake States, such stands are almost always associated with fires. Finley's map shows only widely scattered, small patches of this type and almost none within the northern hardwood-pine regions. There is also evidence that extensive windthrows in hardwood stands were even more common. Often the majority of stumps from old-growth pines are found on mounds or knolls in stands that have a characteristic kettle-knoll microtopography caused by the uprooting action of winds. In fact, numerous studies have shown that disturbances have been occurring in somewhat cyclic fashion in all terrestrial ecosystems (Heinselman 1973, Lorimer et al. 1988).

CLIMAX AND OLD GROWTH

Much unnecessary confusion exists today regarding these two terms. The concept of climax vegetation and in fact the entire concept of succession, as originally defined by Clements and other early 20th century ecologists, have been seriously questioned in recent years (Christensen and

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Peet 1984, Christensen 1987). Community development after a disturbance leads toward a more or less definable *climax community* controlled by regional climate (climatic climax). However, in many areas, due to topographic or soil influences, a regionally uniform climatic climax cannot be attained, except perhaps on a geologic time scale. Such terms as “topographic,” “edaphic,” or “topoedaphic climax” are commonly used to refer to the presumed “terminal” communities on such sites. Thus, in northern Wisconsin the climatic climax of sugar maple, hemlock, and beech can be expected only on more mesic, nutrient-rich soils. The droughtier and less fertile sandy soils simply do not support these demanding species; instead these soils are colonized by a number of shade-intolerant or pioneer species. Because all of the pioneer species on sandy soils are shade-intolerant, they are incapable of replacing themselves through advance regeneration, as is the case with mesic forest species.

Which, if any, species can be considered to represent the edaphic climax on the poorest soils is still not clear. Perhaps the answer to this question is only of academic interest; sooner or later a disturbance inevitably initiates a new cycle.

“Old growth” is a much simpler concept than is climax vegetation. In some cases old growth may also be climax (e.g., a 300-year-old sugar maple—hemlock community without a mixture of white pine), but most often it is simply a community with dominant trees at or near biological maturity (Table 3). However, studies show that very old stands possess ecological properties that differ significantly from those of immature stands of the same floristic composition (Lorimer and Frelich 1992). However, although old growth appears to provide optimal habitat for some species of plants and animals, to date no vertebrate species have been shown to be obligate inhabitants of old growth. Thus, the old-growth ecosystems may best be

Old-growth ecosystems may best be thought of as structural and functional parts of larger landscapes.



thought of as structural and functional parts of larger landscapes. However, most studies have focused on vertebrate species and vascular plants. Habitat needs of invertebrates and lower plants in relation to old growth are largely unknown.

The alliance *Lobarion pulmonaria*, an association of rare lichens, grows primarily in old-growth forests of

northern hardwoods (Thompson 1990).

The early survey records suggest that presettlement forests consisted of a mixture of young, mature, and old forests. Old forests were common in many areas, but successional processes were evident (Lorimer and Frelich 1992).

Old-growth community of yellow birch and hemlock. A recent tip-up creates gap and allows light to release sugar maple seedlings. Photo by Michael J. Mossman.

Table 3

Generalized age characteristics of old growth. Precise age varies with site-specific conditions. Based on representative sites in north-central Wisconsin. Compiled by R. Eckstein.

Cover Type	Age (years)		
	Old Growth Begins	Cover Type Deteriorates	Individual Tree Longevity
Aspen	60	80	150
Northern red oak	100	160	250
White/red pine	130	200	400
Northern hardwood	150	—	350
Hemlock-yellow birch	150	—	500



Old-growth pine forest. An old tip-up creates the coarse, woody debris characteristic of old-growth pine communities. Dunn Lake Pines State Natural Area. *Photo by Signe Holtz.*

THE LOGGING AND EURO-AMERICAN SETTLEMENT ERA

Between the mid-1800s and early 1900s Wisconsin forests were almost entirely cut over. The impact of logging and associated activities was widespread and varied. Space here does not permit a comprehensive treatment of the ecological consequences. Only those factors most responsible for the differences between presettlement and current forest conditions are highlighted.

Early logging concentrated on white pine and, to some degree, on red pine. Scattered trees as well as pure stands were harvested wherever they were found. This had the immediate impact of virtually eliminating the white pine seed source from the northern hardwood complex. Because slash was burned intentionally or unintentionally,

most of the reproduction was also eliminated. Hemlock was removed in a later wave of logging when the tanning industry, which used hemlock bark, was developed.

Hardwoods were harvested last, after railroads and, later, logging roads were built. Both clearcutting and high-grading (i.e., cutting only the most valuable trees) were practiced. Because most hardwoods have less stringent requirements for germination and seedling establishment than do the pines and hemlock, and in addition possess sprouting ability, species such as sugar maple, beech, basswood, yellow birch, and ash were seldom eliminated from a site unless there were repeated fires. However, the species composition of new stands was often severely altered. High-grading consistently favored sugar maple and beech, whereas clearcutting usually resulted in more mixed stands.

A large portion of presettlement forest was later cleared for agriculture. Many cleared lands proved unsuitable for farming and were abandoned. This was especially true for areas with sandier soils that originally supported conifers. Many of these lands were later planted back to trees, but often without regard for site potential and species compatibility. The successful farming that remains in northern Wisconsin is largely confined to sites formerly occupied by high-quality mesic hardwoods.

PRESENT

VEGETATION

Both the species composition and relative proportion of presettlement forest types have been greatly altered by humans. The mixed coniferous-deciduous types have, with a few exceptions (e.g., the Menominee Indian Reservation), lost their coniferous component. Hemlock occurs sporadically in second-growth hardwood stands, but white pine is virtually absent in many areas and shows no signs of regeneration, even where suitable seedbed is created by natural or human-caused disturbance. The necessary supply of seed simply does not exist.

The stump of an old, large white pine (>36" dbh) within an even-aged stand of young sugar maples. *Photo by Michael J. Mossman.*



The relative importance of hardwood species has also changed significantly in many stands. While sugar maple has retained its dominant position, yellow birch is much less common than it once was. On the other hand, basswood and white ash are now usually the most important associates of sugar maple, although they were seldom listed as such by early surveyors.

Most of the presettlement white pine forests (pure or mixed with red pine) are today occupied by mixtures of red oak, red maple, white birch, and aspen, although white pine is showing a remarkable comeback in many areas.

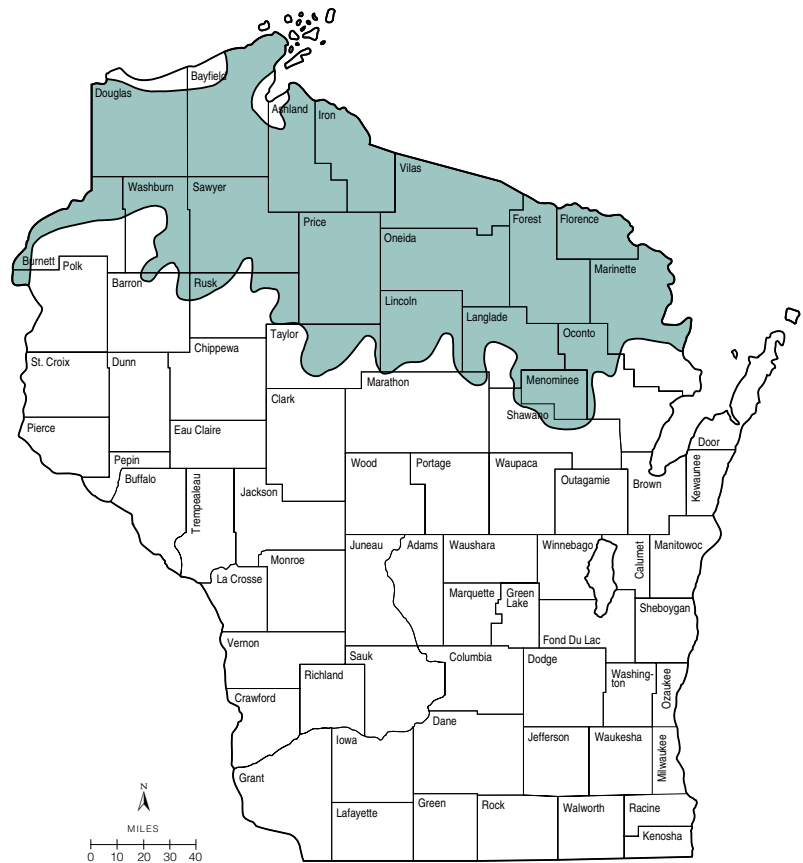
By far the largest change has occurred in the distribution of the aspen-birch type. While scarcely present on Finley's map of presettlement vegetation, today it represents the largest single forest cover type in the state. Much of it extends over the landscape previously occupied by mesic hardwoods, indicating that the post-logging fires also occurred in these communities.

Considering the northern forest region as a whole, the overall species richness of plants and animals does not appear to be threatened. Probably few if any species of flora have been lost, although relative abundance of many has been greatly altered.

Figure 13 shows the extent of the largely continuous northern forest in 1992. The northern forest includes parts of 19 counties. The total land area in forest cover ranges from 59% to 93% on a countywide basis.

There are 8.3 million acres of commercial forest land in the northern forest.² Public land totals 3.5 million acres and ranges from 17% to 56% of the total land in northern forest counties. The forest industry owns 987 thousand acres; forest

² Commercial land is defined as land producing or capable of producing crops of industrial wood and not withdrawn from timber production (Spencer et al. 1988).



industry land ranges from less than 1% to 25% of total land area in northern forest counties. Of commercial forest land, maple-

birch makes up 31%, aspen 29%, elm-ash-soft- maple 7%, paper birch 5%, oak 5%, and balsam fir 5%.³ White cedar, black spruce, white spruce, white pine, red pine, and jack pine forest types each make up less than 5% of commercial forest land. Non-stocked land makes up 1% of commercial forest land (Spencer et al. 1988).

The northern forest is characterized by a sapling and pole-sized forest. Seedlings-saplings range from 6% of commercial forest land in Menominee County to 38% of commercial forest land in Oneida

Figure 13

The continuous, extensive forest of northern Wisconsin, adapted from McCaffery and Creed (1969).

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³ Maple-birch is a loosely labeled type that includes sugar maple, yellow birch, basswood, white ash, and hemlock.

County. Pole timber makes up 49% of commercial forest land. Sawtimber stands do not predominate. This reflects the continual rebuilding and maturation of stands from the cut-over and burned-over conditions at the turn of the century. It also reflects the domination of pole and small sawtimber-size material for timber products as the primary objective of forest management on several million acres of forest land. Sawtimber area and volume decreased from 1936 to 1956, then began increasing from 1956 to 1983 (Stone and Thorne 1961, Spencer and Thorne 1972, Smith 1986).

Pine plantations cover 355,000 acres in northern Wisconsin. Red pine makes up 61% of the total, and jack pine makes up 22% of the total (Smith 1986). Between 1956 and 1968, 500,000 acres were planted in all of Wisconsin. Most acres were planted to red pine (Spencer and Thorne 1972), but red pine was often inappropriate for the site. In addition,

inferior genetic stock, row planting, furrowing, destruction of humus layer, and elimination of ground vegetation caused ecological problems.

The growing-stock volume of nearly every tree species increased between 1968 and 1983, except for elm, hemlock, and yellow birch, for which volumes declined. An average of 21.6 million board feet of hemlock and 14.7 million board feet of yellow birch were removed annually from commercial forest land in northern Wisconsin. These tree species exhibit very low regeneration rates (Raile 1985).

Between 1964 and 1983, 12% of commercial forest land was harvested. Of the 12% harvested, 72% had a partial cut and 28% was clearcut. All past and current logging practices change forest communities. In addition, introduced insects and diseases, such as dutch elm disease and white pine blister rust, have significantly altered the composition of post-settlement forests.

Table 4

Changes in the relative abundance and distribution of selected wildlife in Wisconsin's northern forests: 1850–1994. *Compiled by R. Eckstein.*

Species	Relative Abundance				Distribution			
	Mid-1800s	Early 1900s	Mid-1900s	1994	Mid-1800s	Early 1900s	Mid-1900s	1994
White-tailed deer	Low	Low	Abundant	Common	Clumpy	Clumpy	Continuous	Continuous
Coyote	Low	Common	Abundant	Common	Clumpy	Clumpy	Continuous	Continuous
Bobcat	Low	Low	Common	Rare	Clumpy	Clumpy	Continuous	Clumpy
Moose	Low	Rare	Gone	Rare	Clumpy	Isolated	Gone	Isolated
Snowshoe hare	Low	Common	Abundant	Low	Clumpy	Continuous	Continuous	Continuous
Timber wolf	Common	Common	Gone	Rare	Continuous	Continuous	Gone	Clumpy
Fisher	Common	Rare	Gone	Common	Continuous	Isolated	Gone	Continuous
Pine marten	Abundant	Rare	Gone	Rare	Continuous	Isolated	Gone	Isolated
Elk, wolverine	Low	Gone	Gone	Gone	Clumpy	Gone	Gone	Gone
Bald eagle, osprey	Common	Common	Low	Common	Common	Continuous	Clumpy	Continuous
Ruffed grouse	Low	Common	Abundant	Common	Clumpy	Continuous	Continuous	Continuous
Woodcock	Low	Common	Abundant	Common	Clumpy	Clumpy	Continuous	Clumpy
Sharp-tailed grouse	Low	Abundant	Common	Rare	Clumpy	Continuous	Clumpy	Isolated
Beaver	Common	Rare	Low	Abundant	Continuous	Isolated	Clumpy	Continuous
Grassland birds	Rare	Common	Common	Rare	Isolated	Continuous	Clumpy	Isolated
Interior forest birds	Abundant	Rare	Rare	Common	Common	Continuous	Clumpy	Continuous
Young-forest birds	Rare	Common	Common	Common	Isolated	Clumpy	Continuous	Continuous

ANIMALS

Benyus et al. (1992) compiled a list of 389 vertebrate species present in the northern forests of Michigan, Minnesota, and Wisconsin. The list included birds (71%), mammals (17%), and reptiles/amphibians (12%). Fifty-three percent of these species were uncommon, 37% common, and 10% occasional. These species used all kinds of habitats in all successional stages. Of the forest species, 49% used mature forest and 40% used young forest. Thirty-three species were classified as highly versatile in habitat use, while 204 species had intermediate versatility and 152 species were restricted to specific habitats.

The distribution and abundance of animals in the northern forest have changed dramatically (Table 4). Among mammals, unregulated commercial hunting and trapping as well as dramatic habitat changes has resulted in extirpation of elk, wolverine, woodland caribou, Canada lynx, fisher, pine marten, moose, eastern cougar, and eastern timber wolf. In recent years fisher, pine marten, and eastern timber wolf have been reestablished, and eastern cougar and moose occur in very low numbers.

Lack of large blocks of wild land with low human presence limits populations of some animal species, e.g., eastern timber wolf (Thiel 1985), black bear, bobcat, moose, eastern cougar and spruce grouse. These species are known as extensive forest specialists. These are usually large, wide-ranging, or sensitive animals. The forest need not be mature and can be intensively managed. However, it must have low human presence.

Other mammal species dropped to very low numbers when logging and Euro-American settlement drastically altered their habitat, then increased as the forest began to mature again. These include gray squirrel, porcupine, flying squirrel, and beaver. Still other species, such as raccoon, striped skunk, woodchuck, thirteen-lined ground squirrel, and eastern cottontail, became much more abundant as young forests, edge, resorts, small towns, and



agriculture provided favorable habitat. In recent years, despite maturing forests, badgers have become established in low numbers throughout the northern forest.

Presettlement white-tailed deer populations ranged from five to 15 deer per square mile (Dahlberg and Guettinger 1956, Habeck and Curtis 1959). Deer occurred at very low numbers between 1900 and 1915 but then began to increase (Swift 1946). Abundant favorable habitat caused populations of white-tailed deer and snowshoe hare to grow to very high numbers. Snowshoe hare populations peaked in the early 1930s and were again very high in the 1940s (Cunningham 1993). White-tailed deer populations peaked in the 1940s with 40 to 50 deer per square mile of deer range (Keith McCaffery, Dep. of Natural Resources, pers. comm.). These very high deer and hare populations caused widespread damage to vegetation.

Current Deer Management Unit population goals reflect current forest habitat conditions. Management Unit goals in the northern forest average 18 (range ten to 25) deer per square mile of deer range. Snowshoe hare populations are currently low because of widespread predation, particularly by fisher. The impact of white-tailed deer and snowshoe hare on the composition and structure of forests needs to be viewed on a broad temporal and spatial scale (Mladenhoff and Stearns 1993).

The fisher was once extirpated from the northern forest but has recovered after reintroduction. *DNR photo*

Lack of large blocks of wild land with low human presence limits populations of some animal species.

Many of the human and ecological forces that impacted mammal species also affected bird species. Habitat changes and unregulated commercial hunting extirpated the passenger pigeon from Wisconsin; the species became extinct in 1914. Although common in presettlement and early Euro-American settlement times in Wisconsin, bald eagles, osprey, and Cooper's hawks dropped to low numbers by the mid-1900s because of indiscriminate shooting and reproductive failure caused by pesticides. In the early 1900s, red-shouldered hawks declined as mature lowland deciduous forests declined. Extensive logging, fire, and scattered agriculture created favorable habitat for species such as sharp-tailed grouse, upland sandpiper, eastern bluebird, American goldfinch, golden-winged warbler, American crow, gray catbird, northern harrier, red-tailed hawk and American kestrel. These species are now declining as the forests have grown back and are maturing.

Species that are adapted to young or disturbed forests have increased as this successional stage has increased. These species include ruffed grouse, woodcock, chestnut-sided warbler, mourning warbler, blue jay, rufous-sided towhee, brown thrasher, Nashville warbler, indigo bunting, rose-breasted grosbeak, and great horned owl.

One bird species, the brown-headed cowbird, has increased dramatically in the eastern United States and in southern Wisconsin. In agricultural areas this nest parasite can cause forest bird species to decline. In the northern forest, cowbirds are uncommon but present in local agricultural areas and near towns. In the forested environment, cowbirds are present in first-year aspen clearcuts, young conifer plantations, and large grassy openings. The impact of cowbirds on northern forest bird populations is unknown.

Many of Wisconsin's amphibian and reptile species are found throughout the state, often in wetlands located within other vegetative communities. However, some species with highly specific habitat requirements are found only in the extensive northern forests .

In the past, forest birds adapted to large blocks of mature forest decreased in numbers as these forests were converted to brushland. Examples include the barred owl, pine warbler, Blackburnian warbler, black-throated blue warbler, yellow-bellied sapsucker, pileated woodpecker, eastern wood-pewee, Swainson's thrush, wood thrush, solitary vireo, cerulean warbler, and scarlet tanager. The northern hardwood component of the northern forest is recovering (Stearns 1990) but occurs in smaller blocks (Mladenhoff et al. 1993). It now averages 70 years of age, is developing an all-aged structure, and again supports populations of mature forest birds (Hoffman 1989).

Forest practices can negatively affect some species of forest birds (Temple 1988, Howe et al. 1992). However, properly modified forest practices, in the context of the extensive northern forest, can enhance habitats for forest birds

(Temple et al. 1979, Hoffman and Mossman 1990, DeGraaf et al. 1992, Probst et al. 1992, Thompson et al. 1992, DeGraaf et al. 1993, Thompson et al. 1993, Welsh and Healy 1993).

Forest ponds are breeding habitat for many species of frogs and salamanders. Abundant decaying logs on the forest floor as well as an uncompacted forest floor litter layer are important habitats for salamanders and invertebrates. Many of Wisconsin's amphibian and reptile species are found throughout the state, often in wetlands present within other vegetative communities. However, some species with highly specific habitat requirements are found only in the extensive northern forests (Vogt 1981). Examples are the mink frog, red-backed salamander, and spotted salamander. Other species such as the wood frog, northern red-bellied snake, and wood turtle are most common in the northern forest but occur elsewhere in Wisconsin as

well. Because no thorough inventories have been conducted for Wisconsin's reptiles and amphibians, we have no basis to compare current distribution and abundance with that of the past.

Except for pest species, little research has been directed at forest invertebrates. Lack of knowledge in this area is a serious concern since invertebrates are a very diverse group and perform important ecosystem functions.

THREATENED AND ENDANGERED SPECIES

Threatened and endangered bird and mammal species that have a significant portion of their range in the northern forest include eastern timber wolf, Canada lynx, pine marten, bald eagle, osprey, red-shouldered hawk, and wood turtle. Threatened and endangered plants of the northern forest include moonwort, goblin fern, Smith melic grass, pine-drops, small shinleaf, foamflower, calypso orchid, ram's head lady's-slipper, small round-leaved orchid, Braun's holly fern, drooping sedge, auricled twayblade, broad-leaved twayblade, and hawthorn-leaved gooseberry.

PROJECTED

Projections of future dynamics of Wisconsin's forests are difficult to make without a knowledge of future management or utilization objectives of a changing society. Barring major changes in forest ownership and resource utilization policies, the following trends can be expected:

- ▲ The total forested area will probably remain the same or increase slightly.
- ▲ The aspen-birch type will gradually decrease as forest succession progresses. The area in aspen has declined 1.8 million acres since 1936 (Spencer et al. 1988). Aspen stands today are perpetuated almost entirely by commercial clearcutting. Current utilization is not keeping up with the rapid maturation rate of this short-lived species.
- ▲ Portions of current aspen-birch type will be replaced by various mixtures of white pine, red maple, and occasionally red oak. A significant proportion will succeed to mixed stands of mesic hardwoods, with sugar maple playing the largest role.
- ▲ All forests currently dominated by mesic hardwoods will remain so, but species composition will vary greatly depending on geographic location, site type, and management practices. Sugar maple will become more dominant on many mesic sites.
- ▲ The acreage of red pine plantations is likely to dominate local areas, particularly on forest industry lands. Jack pine acreage is decreasing. Most is going to red pine plantations.
- ▲ Because of great disparity between economic and biological maturity of most tree species, the increase of old-growth forests, in a biological sense, is unlikely. Increased utilization prevents development of old-growth characteristics in managed mature forests.
- ▲ Clearcuts and plantations will continue to fragment large, uniform blocks of mature mesic hardwoods. Temporary edges caused by forest cutting will continue to dominate the northern landscape.
- ▲ Small, permanent grassy openings will continue to decline to less than 1% of public and forest industry lands. Wildlife dependent on grassy, open areas will decline (McCaffrey and Creed 1969).
- ▲ Balsam fir and tag alder will continue to dominate the former white cedar forests. White cedar and Canada yew reproduction will be restricted to scattered, local areas.

The major forest cover types of the northern forest are managed at an economic rotation age. Old-growth forests and old-growth characteristics in managed forests do not develop. Only selected economic tree species, a few forest game species, and selected endangered or threatened species receive funding and management attention. The result is a mosaic of many small stands of widely different age classes.

- ▲ The scattered relict stands containing hemlock and yellow birch will continue to decline. Reproduction of these species will be restricted to scattered, local areas (Eckstein 1980).
- ▲ Fire will not play a significant role as an ecological agent in the northern forest.
- ▲ Road networks will continue to be improved and expanded. Currently, 46% of the northern commercial forest is within 1/4 mile of an improved road (Smith 1986).
- ▲ The demand for forest products such as pulpwood, sawlogs, white-tailed deer, ruffed grouse, characteristics such as wild country and solitude will continue to increase.

ACTIONS CAUSING CONCERN

The major forest cover types of the northern forest are managed at an economic rotation age. This perpetuates a simpler local and regional age structure of forest communities. Old-growth forests and old-growth characteristics in managed forests do not develop. More intensively managed forests lack the snag and den-tree component as well as the horizontal and vertical structure typical of old-growth stands.

Only selected economic tree species, a few forest game species, and selected endangered or threatened species receive funding and management attention. The

Some orchids are quite sensitive to deer and snowshoe hare herbivory and decline with locally high deer and hare populations. Showy ladyslipper. Photo by Staber Reese.



result is a mosaic of many small stands of widely different age classes. Temporary edges are abundant. Large blocks of unbroken mature mesic forest remain rare. Fire as a natural process is rare and is not currently used as a management tool in most areas.

There is pressure by hunters to raise white-tailed deer population goals. Some plants such as Canada yew, hemlock saplings, and some orchids are quite sensitive to deer and snowshoe hare herbivory and decline with locally high deer and hare populations.

Road networks are improving and expanding so that they dominate the landscape in most areas. Housing and recreation interests are developing in more and more wild land, particularly in Oneida, Sawyer, Vilas, and Washburn counties. Large blocks of undeveloped country are declining throughout the northern forest.

State and county agencies currently use no regional landscape overview and do not utilize a unified regional classification system. Forests are managed on a stand-by-stand basis with a bottom-up forest reconnaissance system. There is little consideration of forest patterns and processes using a top-down regional landscape approach. In many cases economic rather than ecological decisions determine management direction. National, state, county, and local public land units plan management strategies independently.

SOCIO-ECONOMIC ISSUES

In the recent past the forest was used primarily as a source of wood products. With the exception of a few periods when there was some concern over the diminishing forest resource, the public was generally unconcerned about the treatment of forests. Biological resources not conspicuously related to timber were largely unrecognized.

These attitudes have changed greatly in recent years. Conflicts between traditional uses of forests, recreational demands, and concerns for natural ecosystem preservation are intensifying. While all factions

agree that each has valid concerns, agreements on the future use of forest resources are becoming more and more difficult to reach.

Although the public is better educated about environmental issues than it has been in the past, numerous misconceptions about the nature of forest ecosystems persist. Many see any disturbance, particularly fire and clearcutting, as unnatural and always detrimental. The process of change through natural succession is seldom appreciated. There are numerous attempts at “preserving” community types that are successional. The hands-off approach is often considered as the only solution to many problems, even though indirect effects of humans are most often present (e.g., introduced insects and diseases, exotic plant species, air pollution, acid deposition, exclusion of fire, etc.).

Development of ecologically sound, cost-effective techniques encouraging natural processes on the forest landscape will require partnerships with the forest landowners, including the forest industry. Public pressure to pay more attention to maintaining complete and functional forest ecosystems will surely continue.

POTENTIAL FOR COMMUNITY RESTORATION

There is great potential for maintaining and enhancing biodiversity in the northern forest. The basic elements of the conservation of biodiversity in forests include tree species composition, stand age, stand structure, and stand area. The key is to use a landscape management approach that accounts for all the characteristic successional stages with forest stands ranging from small to very large (Hunter 1990, Crow 1991, Probst and Crow 1991, Freemark et al. 1993, Haila et al. 1994) (Fig. 14). Characteristic successional stage

Although the public is better educated about environmental issues than it has been in the past, numerous misconceptions about the nature of forest ecosystems persist.



refers to all age classes from seedling through old growth. These successional stages should occur in all stand sizes from small 40-acre stands to large 2,000-acre stands.

Sugar maple stand with a history of logging. Heavy sapling layer shades out ground layer except for maple seedlings.
Photo by Michael J. Mossman.

Public lands occur across the entire northern forest on all major land-forms and soil types. The distribution and abundance of public lands present an opportunity to meet

multiple objectives on a landscape scale. Different landscape objectives can be met on different public land ownerships, depending on the degree of cooperation among agencies. For example, large unmanaged tracts could (and do) occur on National Forests, smaller unmanaged tracts on state forests, and small natural-area-sized tracts on county forests. A regional landscape approach can incorporate management of some forest ecosystems to feature certain species such as white-tailed deer and ruffed grouse while managing other forest ecosystems for plants and animals that require large blocks of mature forest or old-growth forest. The challenge is determining what agency does what, how much, and where.

We suggest that the record of presettlement vegetation be used as an aid but not an absolute model for determining the “desired state” of forest vegetation in a

particular area. There are numerous reasons for this. Most importantly, the presettlement vegetation, as reconstructed from survey records, represents communities based only on dominant tree species present in a particular time period. Subsequent studies, based on hundreds of stands, clearly show that forest communities sharing common dominants often exhibit significantly different floristic compositions when entire floras are compared (Kotar 1987). Similar differences also exist in productivity, rates of succession, associated animal species, and perhaps in other ecological conditions not yet studied.

The forest habitat type classification system (Kotar et al. 1988) is another tool that can be used for assessing the desired state of vegetation on different sites and especially for evaluating the potential for restoring a chosen condition.

POSSIBLE ACTIONS

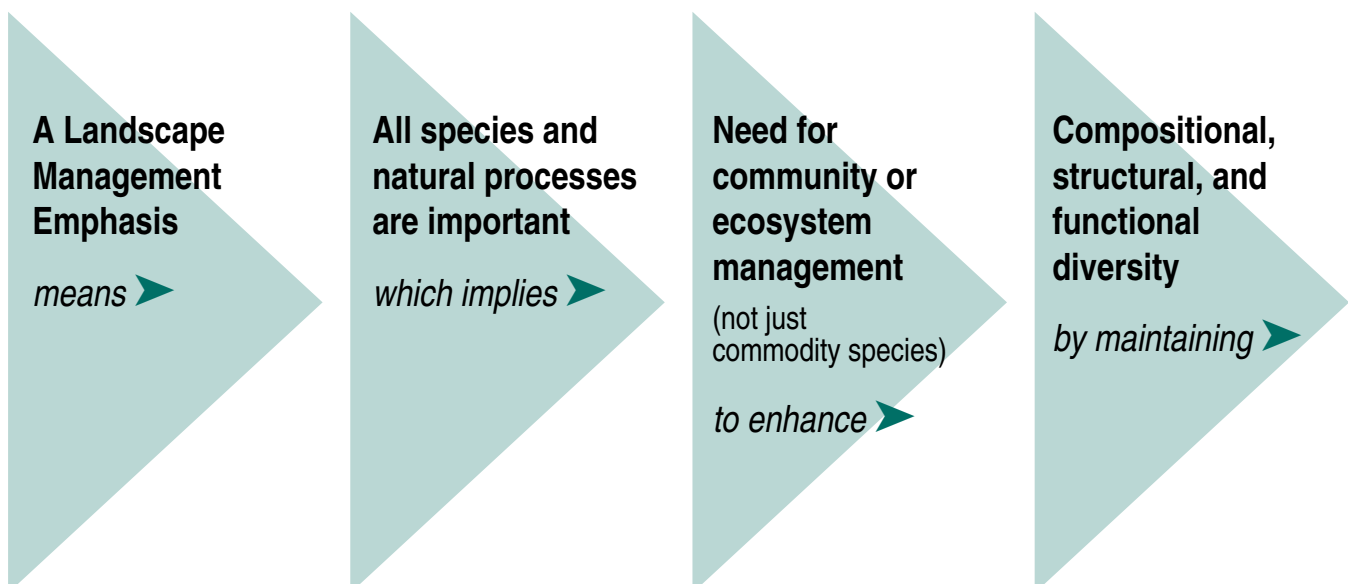
The following possible actions are consistent with ecosystem management, but require more analysis and discussion. How priorities are set within this list will be based on ecoregion goals, staff workload, fiscal resources, public input and support, and legal authority. We will work with our customers and clients to set priorities and bring recommendations to the Natural

Resources Board for consideration beginning in the 1995-97 biennium..

1. Facilitate inter-agency cooperation by creating a Northern Forest Working Group. This Working Group would coordinate information exchange among the various agencies and groups managing the northern forest community. The Working Group could act as a clearing-house for information and could facilitate coordinated landscape planning. For example, meetings have begun between USDA Forest Service, the Department, and the County Forest Association collaborating on research and information-sharing.
2. Encourage the integration of the planning and management functions within each of the land management agencies in Wisconsin. All featured-species forest management guidelines (including forest game, forest vegetation, and endangered, threatened, and nongame species) and all new ecosystem management guidelines should be integrated into one handbook.
3. Encourage inclusion of ecosystem management elements in the Managed Forest Act. Develop guidelines for private landowners to enhance biodiversity. Local diversity could be maintained and improved by developing

Figure 14

Framework for application of a landscape approach within ecosystem management.



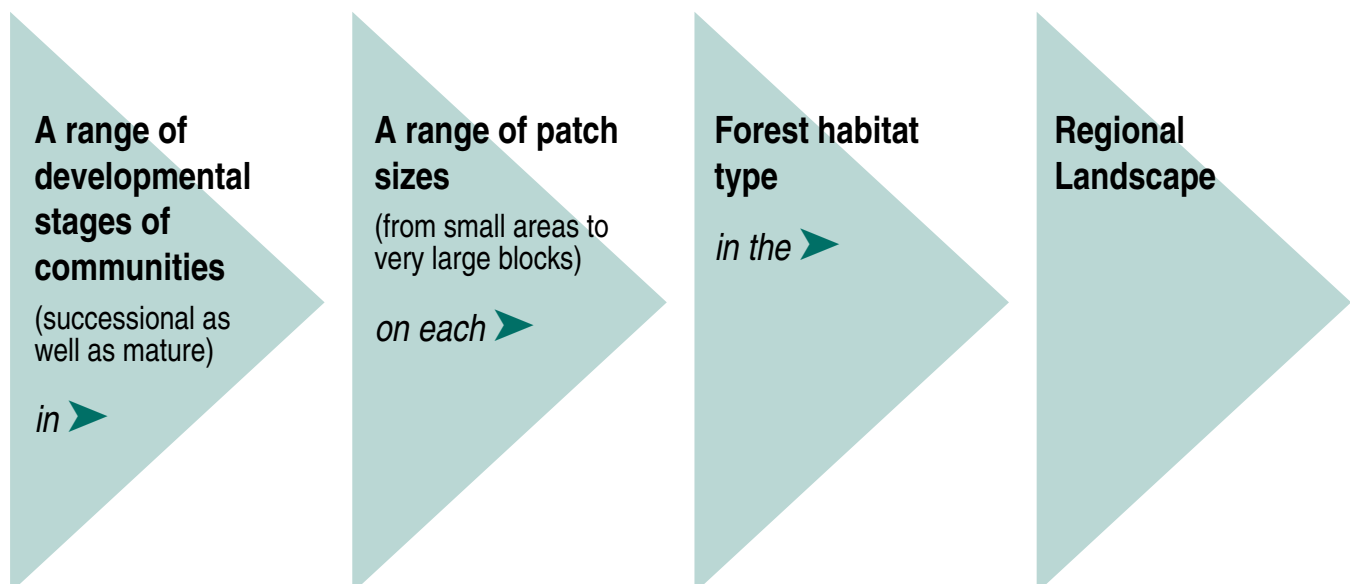
guidelines for snags, den trees, old growth, sensitive habitats, protection of hemlock and white cedar, reserve trees, and extended rotations.

4. Plan and manage public lands using a landscape-scale ecosystem approach. Use a top-down hierarchical approach to plan management across large landscape ecosystems (Noss 1983, 1992; Mladenhoff and Pastor 1993; Bailey et al. 1994) (Fig. 15).

- ▲ Implement the Forest Accord by using the National Hierarchy of Ecological Units (Bailey et al. 1994) combined with the Habitat Classification System (Kotar et al. 1988) to the greatest extent possible. Ecologically based maps would provide information on spatial patterns and interactions of landform, soils, climate, cover types, and potential natural vegetation (Albert 1992, 1993; Bailey et al. 1994). Landscape-scale ecosystem mapping must be coordinated between agencies and landowners across the northern forest so terminology and techniques are consistent.
- ▲ Determine how the various public lands fit into regional and large landscape ecosystems. Then, based on the type of public land, identify

how the various public properties can be managed to meet local, regional, and national objectives. Examples include county forest lands, Department managed lands, lands managed by the Board of Commissioners of Public Lands (School Trust Lands) and National Forest Lands. Protect the unique biological, scientific, aesthetic, and educational opportunities on these lands.

- ▲ Continue implementation of a system of designated natural areas that represent the full spectrum of biological communities across the northern forest.
5. Develop an old-growth policy for state land and encourage the application for old growth on county land.
 - ▲ Develop operational definitions of old growth for Department managed lands.
 - ▲ Defer cutting of existing old growth on state land until an old-growth policy is established.
 - ▲ Old-growth areas in the northern forest must be large enough to meet compositional, structural, and functional objectives (Vora 1994).



Current literature suggests that there are three factors that contribute to the effective size of an old-growth patch: (1) actual size (with a minimum area constraint), (2) distance from similar old-growth patches, and (3) degree of habitat contrast of intervening forest (Harris 1984, Vankat et al. 1991, Vora 1994).

- ▲ A way to enhance each old-growth patch's effective area is to surround each with a mature forest zone managed with single-tree or group selection methods (Mladenhoff et al. 1994). The approach of imbedding old-growth in mature forest zones serves to enhance composition, structure, and function. Efforts should be made to link old-growth patches through use of riparian zones, aesthetic zones, or natural areas.

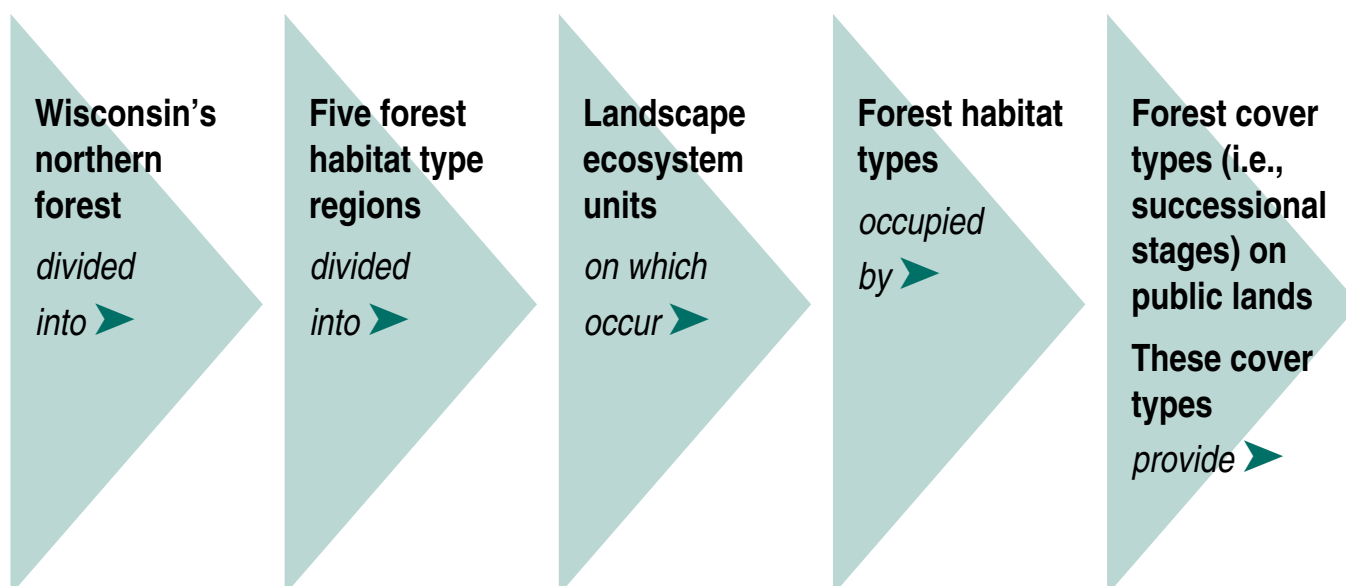
6. Increase relative stand size to reduce edge and increase forest interior conditions. Patch (stand) size is smaller in today's forests compared to presettlement forests (Mladenhoff et al. 1993). In the context of the extensive forest, stands with sizes of 200 to 2,000 acres tend to develop interior conditions favored by a variety of plants and

animals. This recommendation applies to all upland forest types. Landscape planning can help determine the best opportunities to reduce edge and increase forest interior conditions.

7. Continue to improve structure and composition in managed forests.
 - ▲ Apply big-tree silviculture methods, a system originally designed to achieve aesthetic objectives, on state and county forests. Big-tree silviculture is a powerful tool to enhance diversity within and between stands.
 - ▲ Based on a landscape analysis, determine the need to extend the economic rotation for some even-aged stands.
 - ▲ Develop guidelines for structural and compositional characteristics in managed stands. These include large-diameter trees, supercanopy trees, large standing snags, mast trees, large den trees, and large downed trees.
 - ▲ Continue developing guidelines for sensitive habitats such as riparian zones, rare-plant zones, and sensitive-soil zones.

Figure 15

Decision framework for managing on a landscape scale.

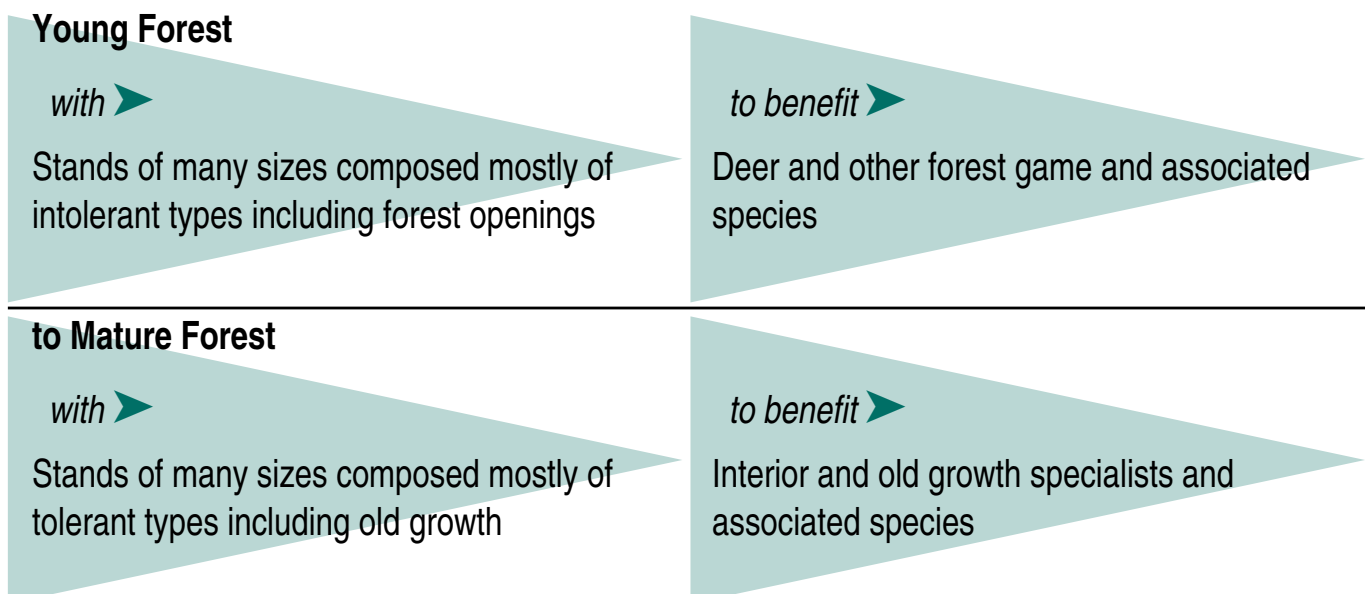


- ▲ Develop prescriptions to maintain tree species diversity. Maintain hardwoods such as oak and red maple in pine stands and intolerant hardwoods such as basswood, yellow birch, and white ash in sugar maple stands.
- ▲ Protect and enhance relict stands of hemlock and white cedar. Enhancement of these stands for species regeneration may require active or non-active management scenarios.

8. Analyze road densities and develop policies for roads on Department managed lands; encourage consideration of this issue on state and county lands. Use landscape scale units to analyze logging road distribution, quality, and abundance. Reduce road densities to protect sensitive plant and animal species and sensitive areas.



Aerial view of small Iron County farms fragmenting the northern forest. *Photo by Michael J. Mossman.*



Case Study

MARATHON COUNTY FOREST: USING GIS TO MANAGE FOREST INTERIOR HABITAT

Contributed by Mark Heyde, Ron Eckstein, and Becky Isenring.

Marathon County owns and manages a 26,747-acre public forest made up of many tracts, mainly concentrated in three areas of the county. Each tract, large and small, is imbedded in a matrix of agricultural and private forest lands. Although this county is on the southern edge of the range of northern forest, it provides a good example of how ecosystem management principles help us address issues of biodiversity across the northern forest.

Populations of a large group of songbirds, neotropical migrants, are in decline worldwide. Although it is not clear which of several factors are most responsible for their decline, the Marathon County Forest wanted to do what they could to contribute to the long-term viability of neotropical migrant bird numbers. Some evidence suggests that nests in small forest blocks are susceptible to high rates of parasitism, predation, and competition from species that tolerate edge habitat. In general, small forested tracts situated in agricultural landscapes provide little habitat suitable for species that are dependant upon forest interior conditions.

Marathon County decided to try to address the needs of the neotropical migrants using a Geographical Information System (GIS). They are using the GIS to analyze the county forest, generating an overview of forest stand types, sizes, and ages within the context of the Marathon County landscape. The GIS is queried for the location of possible and potential interior-forest bird habitat, using guidelines from research in the Hoosier National Forest in Indiana that were adapted to reflect conditions on the southern front of Wisconsin's northern forest. For example, edge was defined in terms of forest stand structure, size of forest openings, location of roads, and the location of nearby agricultural fields. These parameters, applied to GIS map layers, are being used to design a forest management system that reduces edge effects and enhances the area of interior forest habitat.

Marathon County is using a hierarchical approach to look at multiple scales of space and time in planning and designing management activities. The manager considers where the Marathon County Forest is located in the state while considering the position of individual county forest parcels and their composition. With this broad array of information at hand, the manager can lay out a variety of possible future conditions for the Marathon County Forest. In the planning, a wide range of options can be considered, including those that benefit interior forest songbirds.

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